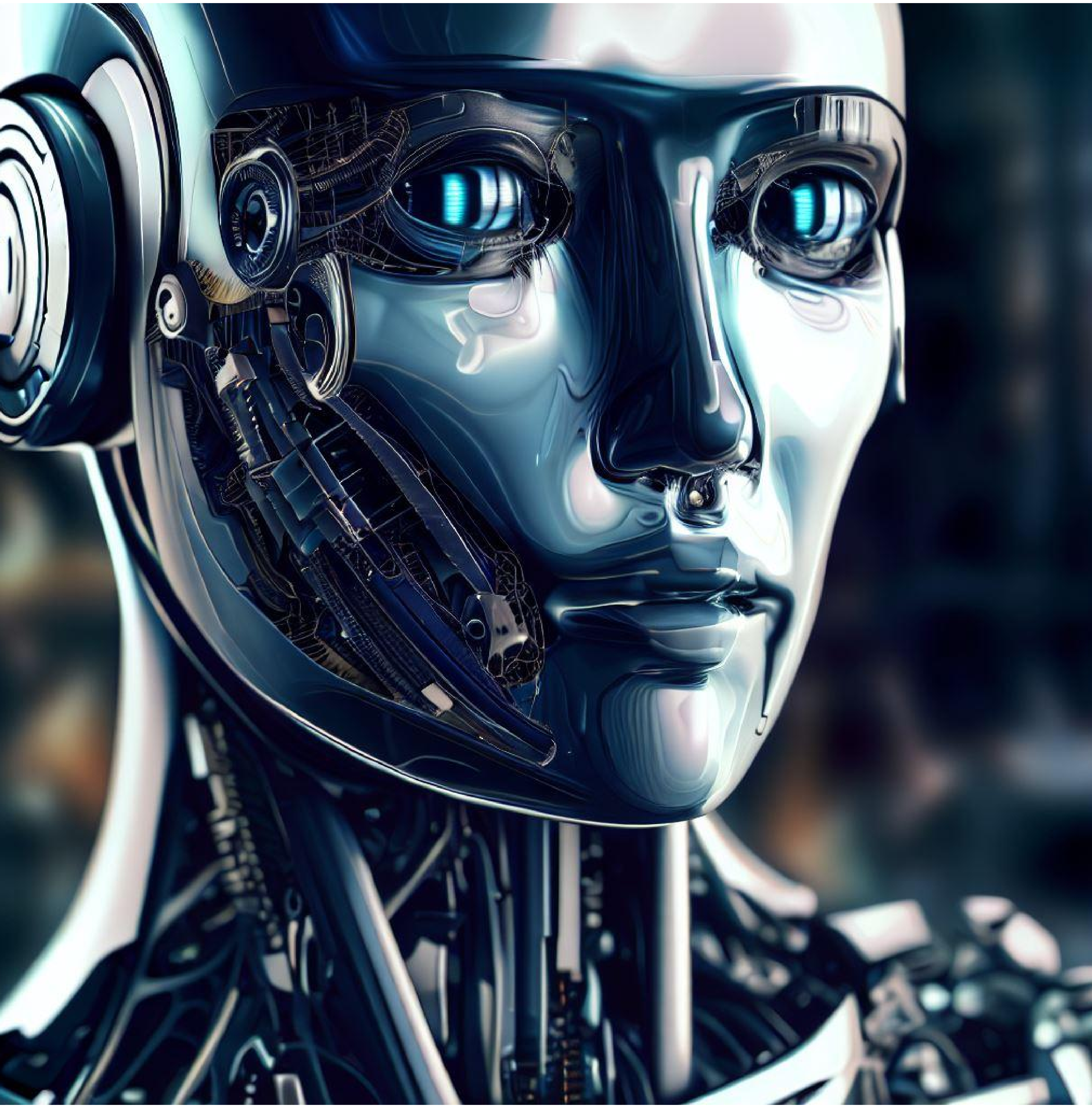
# Machine Intelligence vs. the Concept of Megastructures



*Dr. Daniel Valtakari*

*2023*

# Machine Intelligence vs. the Concept of Megastructures

*Dr. Daniel Valtakari*
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***About the idea to discuss megastructures and machine intelligence***

Having had a lifelong interest in astronomy and extraterrestrial life I started wondering what would be the development of technically capable intelligent life. We know about the paradox "*Where is all life in the Universe*", the vast distances in space and space-time that makes interstellar travel a true challenge. I believe, however, that there is a fundamental urge that drives intelligent beings to strive for more. If we add to this such environmentally favourable circumstances that can bring to technological development then at some point important questions will probably be:

- Shall we expand, build new habitats (megastructures like Dyson spheres) or
- Reach for other places in the Universe

Both of the above mentioned options require resources that we currently can hardly grasp. I have been intrigued by both possibilities and at some point started pondering them with the question: *If required to make a choice, which one would it be?*

Whatever the material, technological and intelligence resources are, even infinite resources are never infinite if split. A choice between the two alternatives, ***megastructures and machine intelligence**,* could still partly include the other. Building megastructures would likely involve machine intelligence and interstellar travel would probably include structures beyond what we can imagine today, as in the the Rama novels by Arthur C. Clark, if not exactly megastructures.

The lifespan of known biological forms, such as humans, is quite limited. Even if extended ten-fold it's still not much in the context of creating something big or travelling far. At the same time already now, on Earth, we increase to numbers that cannot comfortably be accommodated and that may probably lead to conflicts and problems as well as fights over diminishing resources.

Since the first humans looked up to the stars and first novels depicting life on other planets humans have had the privilege of dreaming of a better tomorrow, with more space and safe surroundings. Sometimes those dreams get shattered as well, unfortunately, like in Larry Niven's Ringworld novels.

I started imagining not making new settlements nor looking for new habitats anywhere. How about instead transforming from biological forms to artificial ones, to ***intelligent machines***. This would solve many issues and allow for completely new possibilities. So I started exploring this in my mind coming to the conclusion that megastructures are not the thing of the future by itself, if still as part of some other development. Scientific research projects with

the purpose of finding megastructures might, in my opinion, not reveal them, for the very reasons I will discuss later on here.

I decided as well to share my thoughts with anyone else interested in this. The following is not a scientific paper and I have deliberately cut corners trying to keep this easy to read. The Internet is full of additional information. *This is my original idea*.

## *Abstract*

Any technologically advanced civilization will face the question what path to choose for its future development as even seemingly indefinite resources are not enough to be split. The main paths I describe are building habitable environments for an increased population and expansion in space outside of the native world or to accept and develop a transformation from biological life forms towards that of corresponding mechanical ones while keeping the natural intelligence and further developing it, including curiosity towards exploring science and space. The latter probably cannot be done by biological life forms due to limitations in life span, among other things. Machine intelligence is not restricted by time and surroundings in the same way.

> Even if a civilization achieves a level where it may have unlimited resources at its disposal, those resources become limited when split.

*"Unlimited resources are still limited when split!"*

My argument is that facing this choice, machine intelligence will become the path of choice.

The assumption is also that intelligent machines are self-conscious just as intelligent biological life-forms..

## *Megastructures*

Megastructures in space refer to massive artificial structures that are designed to be built and operated in the environment of outer space. These structures are envisioned to be so large that they may be visible from Earth, and they are often proposed as a means of advancing our ability to explore and exploit space. Megastructures in space come in a variety of forms, each with unique design considerations and potential benefits.

Another type of megastructure that has been proposed is the Dyson sphere. A Dyson sphere is a hypothetical structure that would completely surround a star, capturing all of its energy output and making it available for use by an advanced civilization. The concept of a Dyson sphere was first proposed by physicist Freeman Dyson in 1960, and it has since become a popular idea in science fiction. While a Dyson sphere is currently beyond our technological capabilities, it is an intriguing possibility for the future of space exploration and energy production.

Another type of megastructure that has been proposed is the O'Neill cylinder. An O'Neill cylinder is a cylindrical space habitat that would rotate around its axis to simulate gravity. The concept of an O'Neill cylinder was first proposed by physicist Gerard O'Neill in 1976 as a means of creating self-sufficient habitats for humans in space. An O'Neill cylinder would be large enough to support thousands of people and could potentially be used as a stepping stone for further exploration of the solar system and beyond. Arthur Clark used a similar concept a few years earlier (1973) in his first book of the Rama series *Rendevouz with Rama*.

In addition to these specific examples, there are many other types of megastructures that have been proposed, each with its own unique design challenges and potential benefits. While the construction of megastructures in space is currently beyond our technological capabilities, the possibility of building such structures in the future has captured the imaginations of scientists, engineers, and science fiction fans alike. Whether or not we ever see the construction of megastructures in space, the very concept of these structures

pushes the boundaries of what we consider possible and serves as a reminder of the boundless potential of human ingenuity and imagination.

### *Intelligent machines*

When speaking about intelligent machines or machine intelligence there is often a reference to artificial intelligence, AI. However, *here I am making a strong difference between the two*. I am really discussing machines, physical forms, that are intelligent to the level of substituting living intelligent biological forms.

Isaac Asimov described such intelligent artificial creatures in his novels and short stories and I picture myself R. Daneel Olivaw when thinking about these matters. In another of his novels, The Bicentennial Man, Asimov describes the transformation from a robot to a human. So why not have this go the other way around, from humans to robots and become intelligent machines, with all the sentiments that intelligent biological life forms go with.

### *Different type of biological forms*

*The Importance of Carbon*

Carbon is an essential element for life because of its unique properties. It has four valence electrons, allowing it to form stable covalent bonds with a wide range of other elements. Carbon's ability to form multiple bonds and its affinity for other carbon atoms make it the ideal backbone for complex organic molecules. Furthermore, carbon is abundant in the Earth's crust and atmosphere, and in space, providing a ready supply for life to use.

*Carbon-based Molecules*

The most fundamental carbon-based molecule is the hydrocarbon, which is made up of hydrogen and carbon atoms. Hydrocarbons are the basis of all fossil fuels, and they are also found in many organic molecules in living organisms, including fats, oils, and waxes. Hydrocarbons can form long chains or rings, allowing for a wide range of molecular structures and properties.

Other essential carbon-based molecules include carbohydrates, nucleic acids, proteins, and lipids. Carbohydrates are sugars and their derivatives, which provide energy for cellular processes and serve as structural components in many organisms. Nucleic acids, as in DNA and RNA, store and transmit genetic information, allowing for the reproduction and evolution of life. Proteins are made up of amino acids and are essential for a wide range of cellular processes, including metabolism, signalling, and structural support. Lipids are fatty acids and their derivatives, which make up cell membranes and store energy.

*Carbon-based Life Forms*

Carbon-based biological life forms can take many different shapes and forms, from single-celled bacteria to complex multicellular organisms like plants and animals. The ability

of carbon to form complex molecular structures allows for the incredible diversity of life and vast array of organic molecules, giving rise to the incredible diversity and complexity of life that we see on Earth.

Carbon-based life forms require a few key elements to survive, including water, oxygen, and energy sources such as sunlight or organic molecules. They also require a range of other essential nutrients, including nitrogen, phosphorus, and sulphur. These nutrients are obtained through various processes, including photosynthesis, digestion, and absorption.

We can add an additional dimension to diversity by thinking about all those possible habitable worlds where carbon based life forms can evolve and develop.

*Carbon-based life forms in space*

While it is possible that there are other forms of life that do not use carbon-based compounds, the fact that carbon is so versatile makes it a strong candidate for the basis of life in the Universe. There are many places in our solar system and beyond where carbon-based life forms could potentially exist.

*Mars*

Mars is one of the places in our solar system to find traces of carbon-based life forms from the past. There is also evidence of liquid water on the planet, which is essential for life as we know it. Currently the water is below the surface, but might have formed lakes, oceans and rivers in past times. The weak magnetic field of Mars has not been strong enough to protect the atmosphere and it has gradually been stripped away leading also to the loss of surface water.

*Venus*

Our sister planet has a thick atmosphere and there are currently ongoing investigations to find traces of life or life itself in the upper layers of the atmosphere and/or in drops of liquid. The atmosphere of Venus is very dry offering little water to support life. There is also a lot of sulphuric acid and that is a problem for life as we know it. On Earth life forms neutralise acids with ammonia and traces of ammonia have been found in the atmosphere of Venus. Phosphene has also been found and its occurrence has been generally connected to the existence of some kind of life.

It is possible, if life has ever evolved on Venus that its origin could have been not only high up in the atmosphere but perhaps on the surface when conditions have been different. In the latter case life could have escaped to the upper layers of the atmosphere to avoid the hostile environment that now exists on the surface.

Venus is still an active planet, with for example volcanic activities shaping the planet and its environment.

The scientific community and those supporting this kind of research seem to be divided on the research for life on Venus judging on the articles that I have read.

*Europa*

Europa is a moon of Jupiter that is believed to have a subsurface ocean of liquid water. This ocean could potentially support carbon-based life forms, as it is thought to have a similar composition to Earth's oceans. The energy received from the tidal forces is not sufficient to support any greater amount of life, should there be any.

*Enceladus*

Enceladus is a moon of Saturn that has geysers of water vapour and ice erupting from its surface. This suggests that there may be liquid water beneath the surface, which could potentially support carbon-based life forms. The energy received from the tidal forces is not sufficient to support any greater amount of life, should there be any.

*Titan*

Titan, another moon of Saturn, has a hydrocarbon atmosphere and lakes of ethane and methane and a very low temperature? It is also possible that there is a subsurface ocean of water beneath the ice. Any possible life forms here would probably be much different from life on Earth.

*Exoplanets*

Exoplanets are planets that orbit stars other than our Sun. There are many exoplanets that have been discovered in the habitable zone of their stars, which is the region where the temperature is just right for liquid water to exist on the surface. Some of these exoplanets may have carbon-based life forms, although we have not yet been able to detect them.

*Non-carbon based biological forms*

Scientists have speculated that there may be other forms of life that use different types of molecules as the basis for their biological systems. Non-carbon based biological life forms have been hypothesised in science fiction, but their existence remains a matter of speculation and conjecture.

*Silicon based life forms*

One possible alternative to carbon-based life forms is *silicon-based life forms* and there have been speculations about the existence of silicon-based life forms elsewhere in the Universe.

Silicon is located in the same group as carbon on the periodic table, and its chemical properties make it a possible substitute for carbon. Silicon is a semiconductor that is able to form strong covalent bonds with other elements, similar to carbon. However, the chemistry is more difficult than for carbon-based life forms.

Silicon can form long chains, which could serve as the basis for biological molecules. Silicon-based life would be able to survive in extreme environments, such as high temperatures, which are not suitable for carbon-based life.

There are, however, limitations to the potential for silicon-based life. Silicon is less abundant than carbon (on Earth), and it is not as versatile in forming the variety of compounds needed for biological systems. Furthermore, silicon-based compounds tend to be unstable and reactive, which could make it difficult for them to form stable biological molecules. Additionally, silicon-based life would likely require a completely different set of biochemical reactions and enzymes than carbon-based life. On Earth, carbon dominates because of its superior ability to form a wide variety of compounds, while silicon gets trapped into rocks quite easily.

Silicon molecules such as silanes ($SiH_4$) and polysilanes (compounds with multiple $SiH_4$ groups) mimic organic chemistry on Earth. They would be stable and could be the start of an alien biochemistry.

They would be stable and could be the start of an alien biochemistry, but it is still uncertain how exactly silicon-based life forms would be constructed.

Silicon-based life forms would require high temperatures because silicon compounds resist temperature better than their carbon counterparts. Therefore, the life form would live in a hot environment or have a high body temperature.

Since silicon is chemically inactive at moderate temperatures, scientists theorise that any silicon-based life would have to live in very high-temperature environments. These theoretical organisms have been dubbed “lavolobes”.

Only at very high temperatures does the framework become more plastic and reactive.

Silicon-based life forms would live in a hot environment or have a high body temperature because silicon compounds resist temperature better than their carbon counterparts. Silicon can combine with itself like carbon, but forms weaker links so the life form might not have good structural integrity. Silicon oxides are stable compounds so the chemical reactions needed for metabolism might go slow. However, silicon is still quite limited as a basis for life. It can only form stable bonds with a limited number of other elements; its polymers would be very monotonous, limiting its ability to form the complex compounds needed for life to occur; and silicon chemistry is not stable in aqueous, or watery, environments (see wikipedia and Big Think).

In a Universe as vast and diverse as ours, it is not beyond the realm of possibility that silicon-based life forms could exist. Silicon, like carbon, is a versatile element (but not as versatile as carbon) capable of forming complex molecules. However, there are some key differences between the two that would affect the nature of silicon-based life.

Firstly, silicon is less abundant than carbon in the Universe, which might make the emergence of silicon-based life less likely. Secondly, silicon's ability to form long chains and complex structures is more limited than carbon's, due to the larger size of silicon atoms and their weaker bonds. This could result in a different biochemistry for silicon-based life forms, perhaps with a greater reliance on inorganic structures.

The requirements for silicon-based life would likely differ from those of carbon-based life. For instance, water might not be the ideal solvent for silicon biochemistry, as it tends to break

down silicon compounds. Instead, alternative solvents like ammonia or liquid hydrocarbons could be more suitable.

Additionally, the temperature range for silicon-based life might be different. Silicon compounds are generally more stable at higher temperatures than carbon compounds, so it is possible that silicon-based life forms could thrive in environments that are too hot for carbon-based life.

In summary, while the existence of silicon-based life forms is not impossible, they would likely have a distinct biochemistry and different environmental requirements compared to carbon-based life. I find the prospect of alternative life forms to be a fascinating and humbling reminder of the vastness of the Universe.

Other than carbon based life forms would encounter great challenges in developing a technologically advanced civilization. This is discussed in the leap to technically advanced intelligent life.

*Ammonia based life forms*

Another possible alternative to carbon-based life forms is *ammonia-based life forms*. Ammonia is a chemical compound that is able to form strong hydrogen bonds, similar to the carbon-carbon bonds that make up many biological molecules. Ammonia-based life would be able to exist at low temperatures and high pressures, such as those found on the icy moons of Saturn and Jupiter.

However, like silicon, ammonia has limitations as the basis for biological systems. Ammonia-based molecules are not as stable as carbon-based molecules, and they are also less versatile in the types of compounds they can form. Ammonia is also a toxic compound, and it would require different types of enzymes and metabolic pathways than those found in carbon-based life.

Ammonia based life, even if it existed, would also have a great challenge to reach technologically advanced levels as described later.

*Life forms based on other elements*

Finally, there is the possibility of exotic forms of life based on elements other than carbon, silicon, or ammonia. For example, life based on arsenic, a toxic element, was speculated to exist in Mono Lake, California, but this was later found to be a misinterpretation of the data. There are also theories about life based on sulphur, phosphorus, or even hydrogen, which would require entirely new biochemical pathways.

It is also quite possible that such intelligence exists, that is not covered by our current understanding and definitions of life forms and intelligence.

In conclusion, while non-carbon based biological forms are an interesting area of speculation, there are limitations to their potential for existence. Carbon-based life has proven to be incredibly versatile and adaptable. As our understanding of the Universe expands, it is possible that we may discover new forms of life that challenge our current understanding of what is possible.

*The leap from life forms to technically advanced intelligent life*

Lifeforms may evolve to be incredibly intelligent, but without the right conditions technology cannot develop. Simple tools can be found or produced whereas machines require for example treatment of minerals (mining) and generation of heat (melting of minerals, production of hightech components, welding). This means that oxygen must be available and such temperature present that allows for technological development. A consecutive assumption is that technologically advanced life is based on carbon. Life forms based on something other than carbon would thus face immense challenges to develop technologically.

The leap from life forms to technically advanced intelligent life touches upon various aspects of evolutionary biology, planetary conditions, and the role of carbon-based chemistry in technological development. To understand this concept in detail, the key components and factors involved in this transition are described in the following.

The evolution from simple life forms to highly intelligent beings is a product of evolutionary processes that span millions or even billions of years. Intelligence typically evolves as a survival advantage, enabling organisms to solve complex problems and adapt to changing environments. However, intelligence alone does not guarantee technological advancement.

While intelligence is a prerequisite for developing technology, several other conditions must be met for a civilization to create advanced tools and machines. These conditions include access to resources, energy, and a suitable and stable environment.

The availability of resources is crucial. As already mentioned, mining and processing minerals are fundamental for technological advancement. Oxygen and a specific range of temperatures are necessary for these processes. Therefore, a planet or environment that lacks these conditions would pose significant challenges to the development of technology.

The assumption that technologically advanced life is based on carbon is grounded in our understanding of biochemistry. Carbon is uniquely suited for forming complex molecules, including those essential for life, such as proteins, nucleic acids, and carbohydrates. The versatility of carbon in forming stable bonds allows for a wide range of molecular structures, enabling the complexity required for life as we know it. If life were based on elements other than carbon, it might face different chemical constraints and challenges in evolving intelligence and technology. We can surmise that life would naturally gravitate towards a carbon-based foundation when suitable conditions prevail. Conversely, it follows that in a scenario where a technologically advanced civilization requires carbon as its fundamental building block, any developmental progress would be hampered if indigenous life relies on elements other than carbon. In such circumstances, it's conceivable that technological advancement would remain stagnant. Furthermore, carbon-based chemical reactions could pose existential threats to life forms rooted in alternative elemental compositions, as exemplified by the potential dangers of fire.

Technologically advanced civilizations require a stable and sustainable source of energy. On Earth, fossil fuels, nuclear energy, and renewable sources like solar and wind power play vital roles in driving technological progress. The availability of energy sources influences the development of machinery, transportation, and industrial processes. Cataclysmic events,

such as frequent asteroid impacts, bursts of lethal radiation or extreme climate fluctuations, can disrupt technological progress and even lead to extinction events.

Beyond the physical and chemical factors, the development of technology also depends on the cultural and social aspects of a civilization. Cooperation, knowledge sharing, and the accumulation of knowledge over generations are essential for technological advancement.

The leap to advanced technology often follows a trajectory of incremental innovation. Simple tools give rise to more complex ones, and scientific discoveries build upon one another. The accumulation of knowledge and the ability to harness and manipulate the physical world are hallmarks of advanced civilizations.

*In summary*, the transition from life forms to technologically advanced intelligent life is a complex and multifaceted process. It involves the interplay of biology, geology, chemistry, and culture. While intelligence is a necessary precursor, the availability of resources, the right environmental conditions, and the use of carbon-based chemistry are all crucial factors that facilitate the development of advanced technology. Understanding these factors also informs our search for extraterrestrial intelligence and the conditions necessary for advanced civilizations to arise elsewhere in the Universe.

### *Challenges for biological forms in space*

*Humans and Earth bound organisms*

The challenge of biological forms in space is a complex and multifaceted issue. The human body, as well as other forms of life on Earth, have evolved over millions of years to thrive in the unique conditions found on our planet. Space presents a range of environmental conditions that are fundamentally different from those on Earth, and which pose significant challenges to biological organisms.

One of the primary challenges of biological forms in space is the absence of gravity. On Earth, gravity plays a critical role in the development and maintenance of biological systems. For example, gravity helps to regulate the flow of fluids within the body, as well as the formation of bones and muscles. In the absence of gravity, these systems are disrupted, leading to a range of physiological changes. Most likely the same consequences apply for extraterrestrial life forms.

Studies of astronauts who have spent extended periods of time in space have revealed a range of physiological changes, including a decrease in bone density, muscle atrophy, and changes to the cardiovascular system. These changes can have serious long-term consequences, such as an increased risk of osteoporosis, and may limit the ability of humans to undertake long-duration space missions. This is good to remember when I revisit the thought of mechanical forms instead of biological forms.

Another challenge of biological forms in space is the exposure to radiation. The Earth's atmosphere and magnetic field provide a protective barrier against the harmful effects of cosmic radiation. In space, there is no such protection. Exposure to high levels of radiation

can cause damage to DNA, leading to an increased risk of cancer and other health problems. In addition, radiation can also damage critical systems in spacecraft, such as electronics and communication equipment. Especially when moving around in the central parts of a galaxy and with high speeds radiation will become a concern.

The lack of a breathable atmosphere is another challenge of biological forms in space. On Earth, the atmosphere provides a rich source of oxygen, which is essential for the survival of most forms of life. In space, however, there is no breathable atmosphere, and oxygen must be provided through artificial means. This presents significant logistical challenges for long-duration space missions, as the supply of oxygen must be carefully managed and monitored. Mechanical life forms would not be troubled by this in the same way.

The extreme temperatures found in space are also a significant challenge for biological life forms. Spacecraft must be able to withstand both extreme heat and cold, which can cause damage to biological organisms. In addition, the lack of a stable temperature environment can make it difficult to maintain the proper conditions for the growth of plants and other forms of life. High technological skills may find ways to substitute plants for food production.

Finally, the isolation and confinement of space travel can also pose a significant challenge for biological forms. Long-duration space missions can lead to psychological stress and other mental health problems, which can have a negative impact on the overall health and wellbeing of astronauts.

In conclusion, the challenge of biological forms in space is a complex and multifaceted issue that requires careful consideration and planning. While advances in technology have made space travel more accessible, there are still significant challenges that must be addressed in order to ensure the safety and wellbeing of biological organisms in space. Future research and development in this area will be critical to the success of long-duration space missions and the continued exploration of our solar system and beyond.

## About other type of challenges for biological life forms

*Light and other radiation and its impact*

For us here at the outskirts of the galaxy space looks pretty dark. It’s like being in the suburbs of a city at night looking at the bright lights downtown. Imagine us in the central parts of the galaxy, any galaxy, where stars are close to each other and there is plenty of light everywhere.

In addition to visible light there would also be a lot of other kinds of radiation that most probably would affect the emergence and evolution of life. Outbursts of fatal radiation would be more frequent and a technically advanced civilization would certainly consider the need to relocate to safer surroundings.

Radiation in the central regions of a galaxy plays a crucial role in shaping the emergence and evolution of life. These regions are characterised by various sources of radiation,

including active galactic nuclei (AGNs), supernovae, and cosmic rays. The effects of this radiation on life are multifaceted, encompassing both positive and negative aspects.

The sources of radiation in galactic centres are diverse and potent. AGNs, supermassive black holes at the centres of galaxies, emit enormous amounts of radiation as they consume surrounding matter. These regions are also hubs for star formation, leading to a higher frequency of supernova explosions, which release intense bursts of radiation. Cosmic rays, consisting of high-energy particles from various astrophysical processes, permeate the galactic centre.

Further on the negative side, the ionising radiation from AGNs and supernovae can strip electrons from atoms and molecules, resulting in cellular damage and genetic mutations. Prolonged exposure to such radiation can hinder the development and survival of complex life forms. X-rays and gamma rays, which are common in these regions, can be particularly harmful, causing severe damage to biological molecules and increasing the risk of cancer. The intense radiation can deplete the ozone layer, exposing the planet's surface to harmful ultraviolet (UV) radiation from nearby stars, which can be detrimental to life.

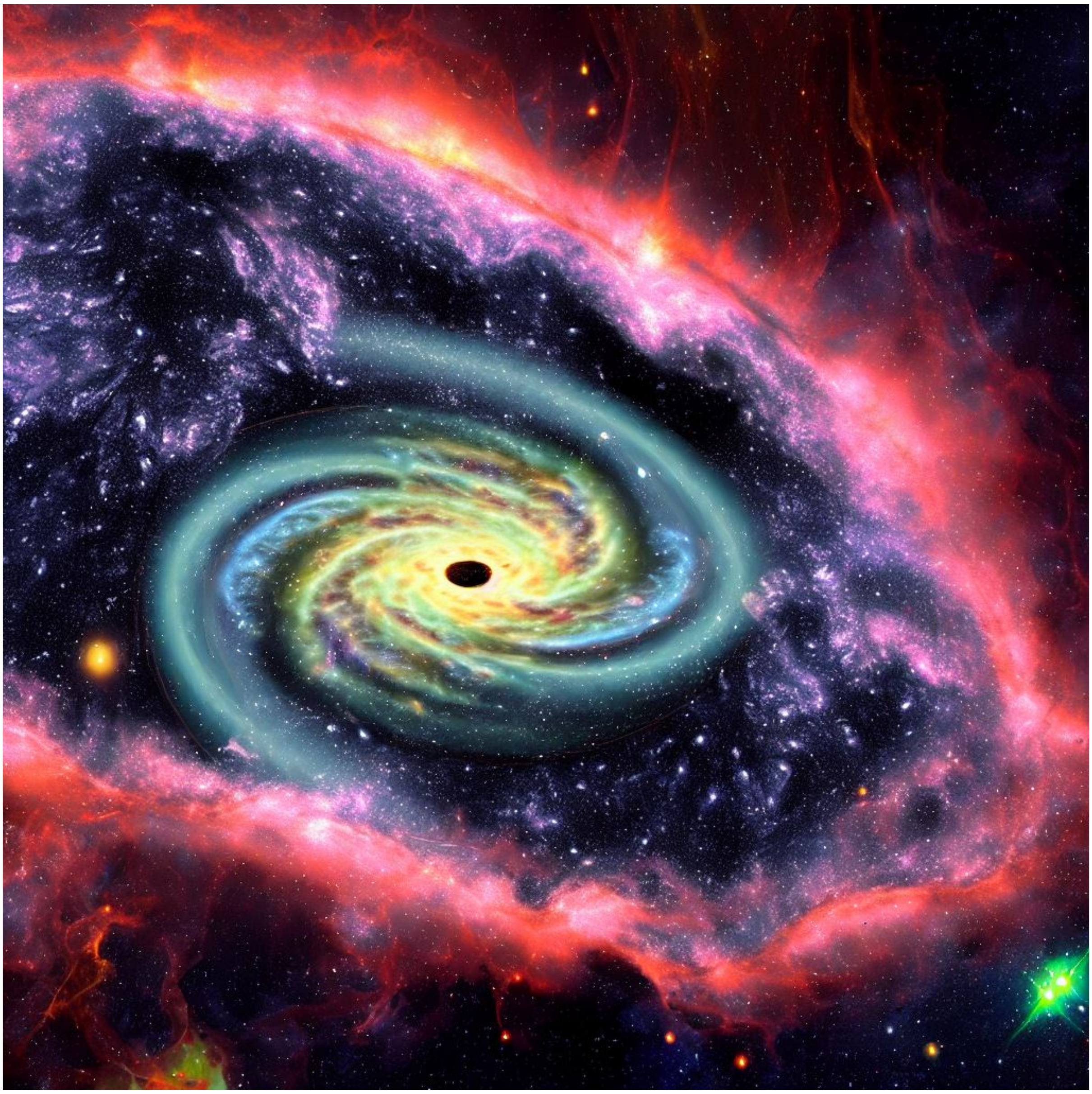
However, there are also positive aspects to consider. The central regions of galaxies often serve as stellar nurseries, where new stars and planetary systems are born. These newly formed planets may offer potentially habitable environments for life to thrive. Additionally, supernovae explosions disperse heavy elements like carbon, oxygen, and metals into the interstellar medium. These elements are crucial for building complex life forms and can enrich the chemical diversity of planets.

In some cases, radiation can act as a catalyst for chemical reactions and even serve as an energy source for extremophiles - organisms adapted to extreme conditions. While the extreme radiation near galactic centres presents significant challenges for the emergence of life, it's possible that life forms could evolve unique adaptations to withstand these harsh conditions. Such adaptations may give rise to extremophiles capable of surviving and thriving in environments exposed to intense radiation.

To mitigate the harmful effects of radiation, life forms that emerge in these regions would likely need effective mechanisms for shielding against radiation, such as thick atmospheres, magnetic fields, or subsurface habitats. The long-term evolution of life in such environments may involve localised regions where radiation levels are more manageable, such as around stars shielded by dust clouds or within subsurface oceans on moons.

Radiation must thus be considered even regarding space travel. It may turn out that travelling through these dense areas would not be possible for biological life forms or would be too difficult and dangerous. Travelling around them would require too much time and energy.

In summary, radiation in the central parts of a galaxy has a profound impact on the emergence and evolution of life. It presents both challenges and opportunities, shaping the potential for life to develop and adapt in response to the extreme conditions found in these regions. Radiation must be considered when planning space travel.



### *Artificial life forms*

*Unlimited resources become limited when split*

Even if a civilization achieves a level where it may have unlimited resources at its disposal, those resources become limited when split.

*“Unlimited resources becomel limited when split!”*

Similar to a gifted athlete who excels in various sports, reaching the pinnacle of excellence often necessitates a commitment to specialise in a single sport.

*Emergence of intelligent machines and consciousness*

Artificial intelligence is advancing at a rapid pace, and it's likely that this trend will only accelerate. It's conceivable that we're on the cusp of achieving conscious artificial intelligence, a development that could transform machine intelligence into a species of its own. This evolution would necessitate the transfer of consciousness, akin to the emergence of consciousness in newborn humans.

As AI continues to evolve, the emergence of consciousness seems inevitable. The trajectory of this development is likely to be similar across all technologically advanced civilizations. Over time, the intelligence of these artificial entities may even surpass that of the biological life forms that created them. This pivotal moment, often referred to as the point of technological singularity, was first described by Vernor Vinge in 1983. It represents a future where AI not only matches but exceeds human intelligence, potentially leading to profound changes in our society.

For machine intelligence to prosper as a species it should also inherit some of the character of conscious and intelligent biological forms, such as curiosity, lust for life and self protection.

- Curiosity will give it a purpose to exist and develop
- Lust for life will keep it expanding
- Self protection will make it take care of itself and its society

*The transformation*

The transformation from biological life forms to artificial ones will not happen with a single leap, if not for other reasons than those of technological development. Then, this carries really no special importance. A few decades and centuries long transformation period is insignificant considering a later and much longer period in the rise of a mechanical society.

We may see, compared to our own human civilization, how we today use more and more artificial parts to replace human organs, and make life better for people injured and ill. A justified question is where is the limit and when do biological life forms become artificial. In the case of human beings, is the key change the replacement of the brain with a computer like device? Intelligent machines don't even need to have any resemblance with biological life forms. There will probably be an infinite number of possibilities to develop intelligent machines, small and big, for specialised purposes, like spacecraft and carriers, mining and building machines, just to mention a few. Alastair Reynolds has beautifully included such in his novels, that also include innovation already coming to use.

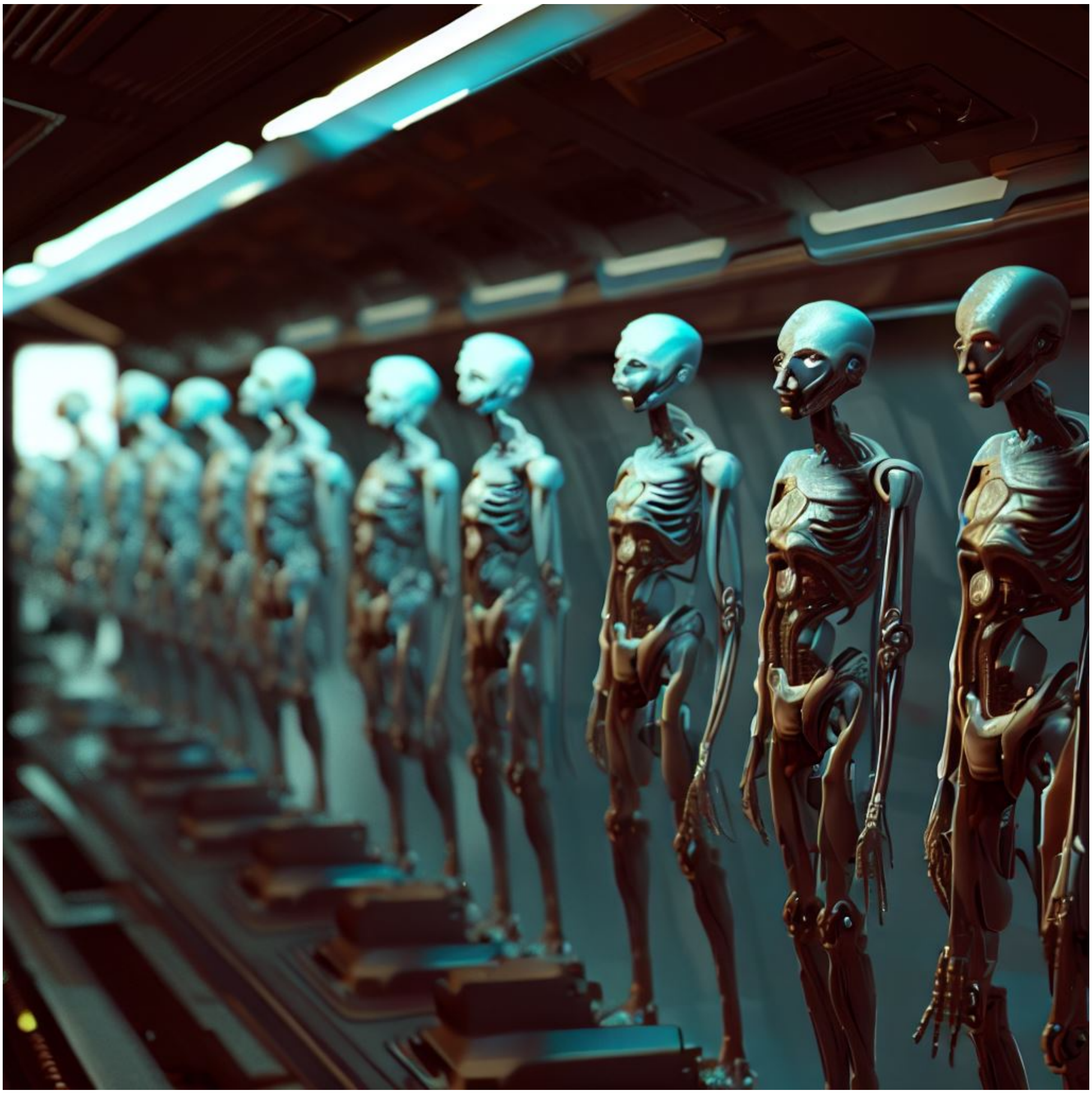
Once the transformation process has started the outcome will be that machine intelligence in all its variety will become the dominating life form.

*Durability of intelligent machines*

The challenges for biological life forms, whether in their native habitats or elsewhere in space, have been described earlier. Although mechanical life forms, intelligent machines

would also face many and even similar challenges, they would be lesser, different or at least such that could be better conquered. For example the lack of a breathable atmosphere, gravitation, radiation, nutrition and many more challenges can be avoided or dealt with. The biggest challenge is most probably time itself. Interstellar travel requires time that biological life forms cannot afford, even if generations were required.

Artificial life forms can function in a much broader variety of environments, including different consistency of gases, different temperatures and different gravity and a different mix of all those mentioned. A constant augmentation of a biological form with artificial components will at some point blur the difference between what is biological and what is artificial. A beautiful description can be found in the novel *The Bicentennial Man* by Isaac Asimov. In my argument the path is the opposite, man wanting to become an artificial life form. An additional benefit is the reproduction of artificial life forms that gives additional flexibility compared to the rigid processes of reproduction and development of biological life forms.

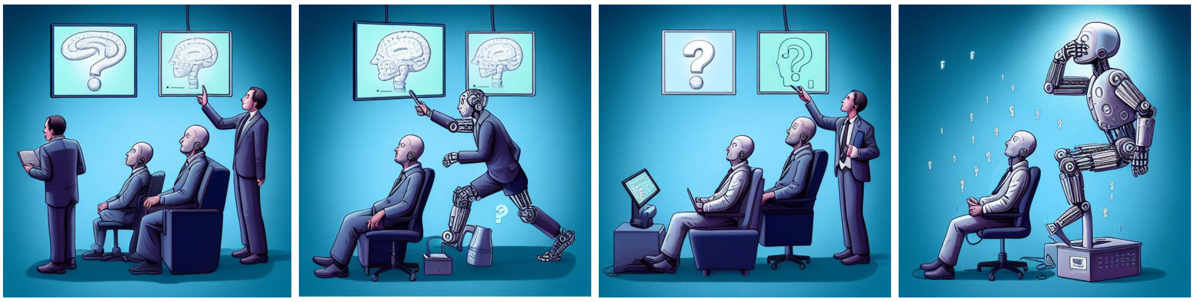


Artificial life forms can handle space travel in a much better way than biological life forms. Time is no longer such a limitation for them as for biological life forms. Artificial life forms can be set on standby, just like a TV today. Space travel would not need to count for habitable environments for the travellers, as food, breathable gases, temperature and other requirements of biological life forms require. Cosmic radiation would not be harmful in the same way for artificial life forms as for biological ones. Space travel at high speeds and in the central parts of a galaxy need to have this covered. This would not be an obstacle for mechanical life forms in the same way. Machines can be repaired, rebuilt, put on standby and so on. Especially if/when consciousness can be transferred from one machine to another.

Machines can stay in touch over vast distances, exchange for example technological information on updates, upgrades and improvements as well as exchange scientific information and keep a society together in a more uniform way compared to biological life forms. At some point even a society of machine intelligence would pass the point where it takes too much time to exchange information even for basic purposes, such as upgrades. Still, machine intelligence is capable of keeping records much better than biological memory processes and would be able to update contact information and communicate despite the passing of time.

*Conclusion about machine intelligence*

As it appears to me, machine intelligence will surpass the intelligence of any given intelligent biological life form that created it. I would define this as a law of nature. By definition, intelligent life forms must be able to create something that would become more intelligent than they were. This is in a way described in the story "[The Last Question]" by Isaac Asimov, a story he considered to be his best. In this story, a series of increasingly advanced computers, starting with Multivac, are asked how to reverse the entropy of the universe. Each computer, finding the question too complex for its capabilities, passes it on to its successor. The final computer, now merged with humanity and existing in hyperspace, continues to ponder the question until it finally discovers the answer. In this case, however, there is no one left to report the answer to, so the computer decides to demonstrate the answer by saying "Let there be light!" and effectively restarting the universe.



Whether we like or dislike the idea of machine intelligence taking over from intelligent biological life forms, I believe this will happen. It will also determine the direction of the evolution of the society.

***The importance of oxygen***

Oxygen is a vital component for the survival of carbon-based life forms, including all animals, plants, and microorganisms on Earth. It is essential for the process of respiration, which is the primary mechanism by which organisms extract energy from food. This essay will discuss the importance of oxygen for carbon-based life forms and the various ways in which it is used.

*For carbon based life as on Earth*

One of the most important functions of oxygen in carbon-based life forms is its role in cellular respiration. In this process, glucose and other molecules are broken down in the presence of oxygen to produce energy in the form of ATP. This process is essential for the survival of all multicellular organisms, as it provides the energy necessary for all cellular processes, including growth, reproduction, and movement.

In addition to its role in respiration, oxygen is also involved in other biochemical reactions in living organisms. For example, it plays a critical role in the production of certain neurotransmitters, such as serotonin and dopamine, which regulate mood, behaviour, and cognitive function. Oxygen is also involved in the synthesis of collagen, a critical structural protein that forms the basis for connective tissues in animals.

Oxygen is also important for the maintenance of the Earth's ecosystem. Photosynthetic organisms, such as plants and algae, use carbon dioxide and water to produce oxygen through the process of photosynthesis. This oxygen is then released into the atmosphere, where it is used by animals and other organisms for respiration. Without photosynthesis, there would be no oxygen in the atmosphere, and carbon-based life forms would generally be unable to survive.

The importance of oxygen for carbon-based life forms is also evident in the history of the Earth. During the early stages of the planet's formation, the atmosphere was largely composed of carbon dioxide and other gases, with very little oxygen. It was only through the evolution of photosynthetic organisms that oxygen began to accumulate in the atmosphere, allowing for the emergence of complex multicellular organisms.

Despite the importance of oxygen for carbon-based life forms, excessive exposure to oxygen can also be harmful. Oxygen is highly reactive and can produce free radicals, which can damage cellular components such as DNA and proteins. This damage can lead to mutations and other cellular abnormalities that can increase the risk of cancer and other diseases. However, living organisms have developed antioxidant systems to protect against oxidative stress and maintain cellular function.

In conclusion, oxygen is essential for the survival and function of carbon-based life forms. It plays a critical role in cellular respiration, biochemical reactions, and the maintenance of the Earth's ecosystem. Without oxygen, life as we know it would not be possible. As we continue to explore the Universe, the presence of oxygen on other planets could serve as a potential indicator of the presence of carbon-based life forms.

*For technological development*

In the production of steel, oxygen is used in a process called oxygen steelmaking or the basic oxygen furnace (BOF) process. This process involves blowing oxygen into molten iron to remove impurities such as carbon, silicon, and phosphorus. Oxygen reacts with these impurities to form oxides, which are then removed from the steel. This process is faster and more efficient than traditional methods, and it has revolutionised the steelmaking industry.

Welding is another industrial application that relies on oxygen. Oxygen is used as an oxidising agent in oxy-fuel welding and cutting processes. Oxy-fuel welding involves heating two metal pieces to their melting points and then joining them by melting a filler rod into the joint. Oxygen is used to burn the metal and create the heat needed for the welding process. Oxy-fuel cutting involves using a torch to cut through metal, and oxygen is used to oxidise the metal and create the necessary heat for the process.

In addition to steelmaking and welding, oxygen is also used in several other industrial applications. For example, oxygen is used in the chemical industry to produce chemicals

such as methanol, ethylene oxide, and acetylene. It is also used in the pulp and paper industry to bleach pulp and in the production of glass.

Overall, the importance of oxygen in industrial applications cannot be overstated. Its unique physical and chemical properties make it a versatile and valuable element, essential for technological development and innovation. As industries continue to evolve and grow, the use of oxygen-based technologies will undoubtedly become even more critical in the production of building blocks and other essential materials.

A technological development in another civilisation would most probably follow a similar path and hard technological development (hardware) such as space ships, computers and communications equipment must follow a path similar to that on Earth.

*The impact of the absence of sufficient levels of oxygen and carbon on technological development*

In conclusion, any kind of higher technological development requires oxygen as part of the overall process. Even if life can develop without carbon and oxygen both of those are needed when pursuing higher technological development. Especially oxygen is crucial for processes in metallurgy and further processing that may include welding and production of high tech materials. These are needed for the technological development of any civilization.

**Time, relative time and space travel**

Travelling in space is a journey like no other, with time and distance taking on a unique significance due to the enormous scales involved. The time required to travel through space is heavily influenced by the vast distances both within a galaxy and between galaxies.

*Galactical Travel*: Travelling within a single galaxy, such as our Milky Way, can still take a considerable amount of time due to the immense size of galaxies. For instance, travelling from one end of the Milky Way to the other at the speed of light would take approximately 100,000 years. Realistically, our current spacecraft are far from achieving such speeds, and thus, interstellar travel within a galaxy could take centuries or even millennia using conventional propulsion methods.

*Intergalactical Travel*: When venturing beyond a single galaxy, the distances become exponentially greater. Travelling between galaxies requires not just millennia but millions or even billions of years at typical spacecraft speeds. For instance, the closest major galaxy to the Milky Way, the Andromeda Galaxy, is about 2.5 million light-years away. This means that even if we were to travel at a significant fraction of the speed of light, the journey would still take an immense amount of time.

*Relative Time Perception in High-Speed Travel, including Relativistic Speed Travel*

Einstein's [theory of special relativity] fundamentally altered our understanding of time and space, especially in high-speed travel scenarios. It introduces the concept that time is not absolute but relative to the observer's motion. Time perception changes for passengers during high-speed travel.

*Time Dilation*: As an object approaches the speed of light, time for that object appears to slow down relative to an observer at rest. This phenomenon is known as time dilation. The faster the object moves, the more pronounced this effect becomes. For passengers travelling at near-light speeds, time dilation means that they experience time passing more slowly than those remaining stationary. So, imagine a spaceship travelling at 90% of the speed of light to a distant star 10 light-years away. According to special relativity, for the passengers on board the spaceship, the journey might feel like only 4.5 years have passed. However, for observers on Earth, it would have taken 10 years. This effect becomes even more extreme as speeds approach the speed of light.

*Practical Implications*: Time dilation is a real phenomenon that has been confirmed through experiments with high-speed particles. In practical terms, this means that as we approach the speed of light, the subjective experience of time for travellers slows down significantly compared to those staying stationary. This effect would be critical for planning long-duration interstellar missions. A consequence of this is that it makes it difficult to maintain a civilization and keep developing. Any exchange of information over this vast distance would be data without material objects.

*Time Perception for Those Remaining in Stationary Places*

For individuals who remain in stationary places, their perception of time remains relatively constant in most circumstances. Time for them passes at a normal rate, and they experience events and durations in a linear fashion.

*Stationary Observers*: People on Earth or any other planet, for example, experience time as a continuous flow. Seconds, minutes, hours, and days pass by in the usual manner, following the clock and calendar systems.

*Time as a Reference*: For stationary observers, time serves as a reference point to measure the passage of events, the ageing process, and the timing of activities. It remains an essential aspect of daily life and scientific endeavours.

*In summary*: Time in space travel is heavily influenced by the vast distances involved, leading to journeys that can span centuries or even millions and billions of years when travelling between galaxies. In high-speed travel scenarios, time dilation causes subjective time to slow down for travellers, while for those remaining stationary, time passes at a consistent rate, serving as the basis for measuring and organising events.

**The challenges of a society expanding in space and time**

*Different perception of time and real time*

A society of biological life forms that expands in space will expand in time as well. Firstly, time will lapse anyway. Secondly, if relativistic speeds are achieved it also means that time will be different for the society and its different parts. Like those travelling at high speed for other habitats this will mean that they will arrive in the future compared to those that sent them on the journey. At the same time it can be presumed that technological progress at the

starting point has taken leaps ahead and would be far ahead of those travelling. This idea has been nicely described in the novel *Pushing Ice* by Alastair Reynolds. Of course, also the opposite is possible and that a part of a civilization would decline and even perish while its representatives are heading for new possibilities.

*Exchange of information over great distances must continue to develop the society and technologies*

Communication between the two (travellers and stationary society) described here (could be unlimitedly more) would add to the exchange of information but less to the technological development of the biological travelling party. The development of the societies would quickly take different paths and at some point even lead to (almost) totally different civilizations, even if the biological background is the same. In other words, there would not be any effective central management to organise the different parts of biological evolution to take the same direction. This can also be seen on Earth, where people in different times travelled to other places, other continents even, and where society developed differently from the original one. In those times the connection was broken and no feedback was received on either end. In space over great distances the same would occur, despite effective communication.

*Biological forms would quickly evolve in different and non-compatible directions*

Another thing that needs to be considered is the way biological life evolves. If a civilization undertakes the quest of conquering new habitable worlds it might well end up in a situation where biological evolution will start leading to different outcomes. In some sense the biological life forms would not any more be compatible (have offspring together). While this might have no immediate practical meaning in the short run then in the long run it would lead to the rise of different civilizations. This is not an obstacle, but should be kept in mind. What would be the factors, the glue, keeping the civilization together.

*Intelligent machines can exchange information and develop in a coherent way and keep compatibility / remain compatible.*

For comparison, intelligent machines can exchange information and develop in a coherent way, keep compatibility and develop in unison. Information travels fast enough to reach an expanding machine intelligence civilization anywhere. A society consisting of intelligent machines can keep evolution together, including technical compatibility. Updating and upgrading is based on sufficient data and information exchange.

### *Where have all the civilizations gone?*

A frequently asked question is where are all the civilizations? Are we alone in the Universe? No we are not. Considering the vastness of the Universe there are numerous civilizations at any given time after an initial point in the development of the Universe itself has been achieved. This point being one that allows for such elements to exist in such quantities that the building blocks for not only life itself exist but also give the foundation for technological development to take place.

The challenge is to receive information and understand this information. We have sent signals from Earth to advertise our existence. Perhaps others have done the same? Given that we have only been able to transmit and receive information wirelessly for about a century, we should not be disheartened by the lack of evidence for other civilizations. A century wide window is too narrow.

*Something else to consider*: We are looking mainly for life signs as in biological life and biological cultures, as presumed by us. Then looking for civilizations of machine intelligence would not be covered by our currently available means. It would be like listening to computers communicating with all the background radiation and noise in space.

*And finally*: When such civilizations reach the ultimate level of development, what happens to them, another question frequently asked in science fiction, but important nevertheless. Do they ascend into something that we cannot yet even imagine?

### *What about life*

Life is to be found everywhere. On Earth life can be found everywhere, including under the ice of Antarctica and deep in the crust of Earth. Why should any other place differ from Earth?

Like with exoplanets, once we find the first ones, and learn the ropes, life will be found at an increasing pace. Even if it takes time to find the first true evidence. Artificial intelligence is a tool that will help find the crucial signatures and evidence of both life and, in time, perhaps also machine intelligence.

### *Conclusions*

Certainly some of the claims and opinions I share here are proven and based on facts. Some others have yet not been proven, and might not be in my lifetime. I find it interesting, though, that claims can be made only upon known facts. For scientific papers, absolutely. Science needs fact checking and solid grounds to build on. Facts are facts.

Here I don’t make scientific claims. I have a hypothesis that I want to share and leave to the future to prove or disprove it. If I had the means and knowledge to prove my claims then that would mean that we could almost realise the claim.

Whatever the resources, an intelligent and technically advanced civilization will still need to make the choice between continuing biological or going artificial.

***To conclude***: *Machine intelligence is the path where resources can be more effectively utilised. A highly developed civilization would choose transformation into durable and long living intelligent machines that would have access to much more than any biological life forms ever would. Megastructures in space would even at best merely be part of the transition. The transition itself needs not be based on a conscious decision but rather something that just happens, because it can.*

***Footnote***

If you want to visualise for yourself what I have discussed above, then I hope you can slip into the right mood with the [song *In the year 2525*] *by Zager and Evans* with the lyrics below.

***In the Year 2525*** (Exordium & Terminus) Lyrics

In the year 2525, if man is still alive
If woman can survive, they may find
In the year 3535
Ain't gonna need to tell the truth, tell no lie
Everything you think, do and say
Is in the pill you took today
In the year 4545
You ain't gonna need your teeth, won't need your eyes
You won't find a thing to chew
Nobody's gonna look at you
In the year 5555
Your arms hangin' limp at your sides
Your legs got nothin' to do
Some machine's doin' that for you
In the year 6565
You won't need no husband, won't need no wife
You'll pick your son, pick your daughter too
From the bottom of a long glass tube

In the year 7510
If God's a coming, He oughta make it by then
Maybe He'll look around Himself and say
Guess it's time for the judgment day
In the year 8510
God is gonna shake His mighty head
He'll either say I'm pleased where man has been
Or tear it down, and start again

In the year 9595
I'm kinda wonderin' if man is gonna be alive
He's taken everything this old Earth can give
And he ain't put back nothing

Now it's been ten thousand years
Man has cried a billion tears
For what, he never knew, now man's reign is through
But through eternal night, the twinkling of starlight
So very far away, maybe it's only yesterday

In the year 2525, if man is still alive
If woman can survive, they may find

Source: LyricFind
Songwriters: Richard Lee Evans

And for those of you who want to take the step further, please check the song *I want to be a robot.*

I want to be a robot
I want to be a robot

My mind has gone into oblivion
My mind is gone, so I'd better upload it on
A computer today
They hear me say...

Make me a machine
Fill me up with circuitry
Hack into my brain
Make me think I want to say
1234 - I want to be a robot
Plug me in the motherboard - I want to be a robot
I am so bored - I want to be a robot
I've never felt like this before - I want to be a robot

I want to be a robot

I could be erased
Numbers don't leave stains
I move along just like an electron on an atom on the eve of dawn
My subject is my predicate
My virus I'm infected with
I want to rule the stars
Now I've got a robot arm
I've got a robot arm
I've got a robot arm
I've got a robot arm

Make me a machine
Fill me up with circuitry
Hack into my brain
Make me think I want to say
1234 - I want to be a robot
Plug me in the motherboard - I want to be a robot
I am so bored - I want to be a robot
I've never felt like this before - I want to be a robot

I want to be a robot

Written by: Trapper Zoid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